Blood Components:
Collection, Characteristics, and Secondary Processing

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Pre-Presentation Questions

Think of the answers now — we'll revisit after the talk

Q 1 What is the primary advantage of component therapy over whole blood transfusion?

Q 2 What laboratory value is used to define 'Low Titer' in Low Titer Group O Whole Blood (LTOWB)?

Q 3 Which blood component has the shortest standard shelf life under current storage guidelines?

Answers revealed at the end!

Overview

1

Collection Types

Apheresis vs. Whole Blood donation

2

Component Manufacturing

Reveos instrument & processing workflow

3

Low Titer Group O WB

LTOWB in trauma, ABO titers & hemolysis risk

4

Blood Components

RBC, Plasma, Platelets — storage & shelf life

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Component Modifications

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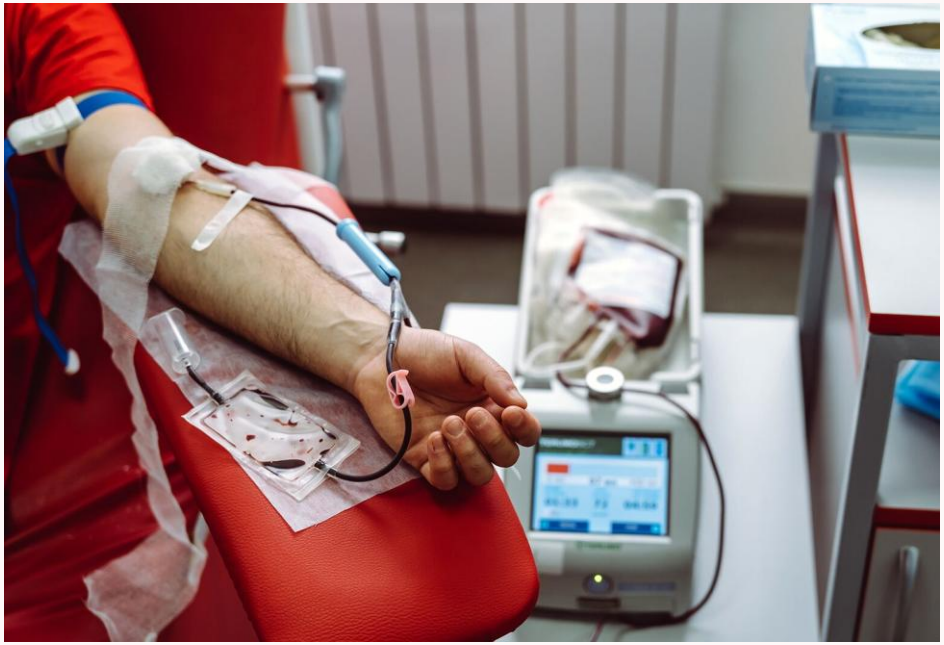
Section 1: Collection Types

Apheresis vs. Whole Blood Donation

Whole Blood Collection

The traditional model — one donation, multiple components



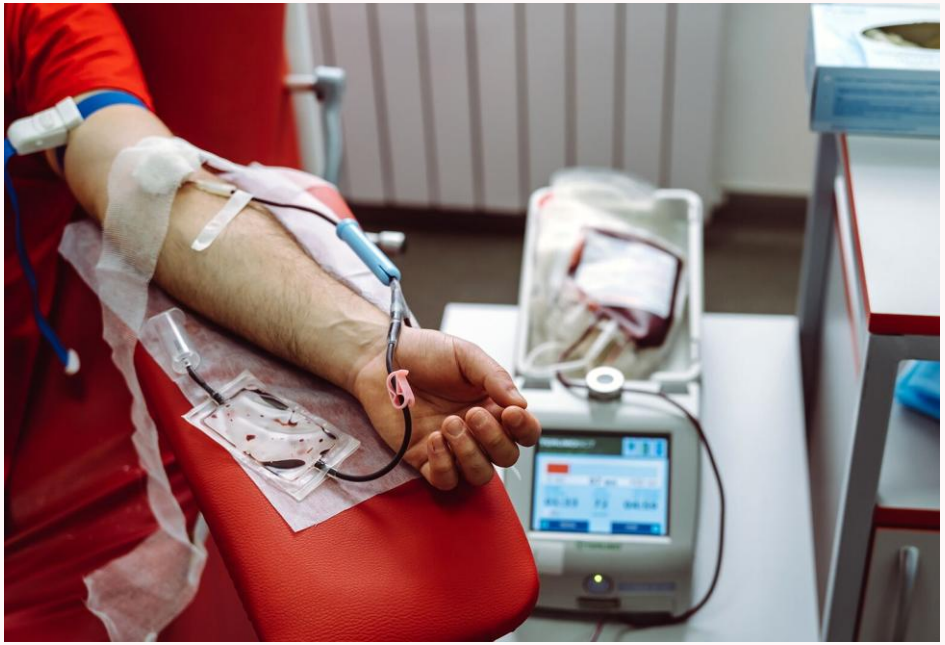
How It Works

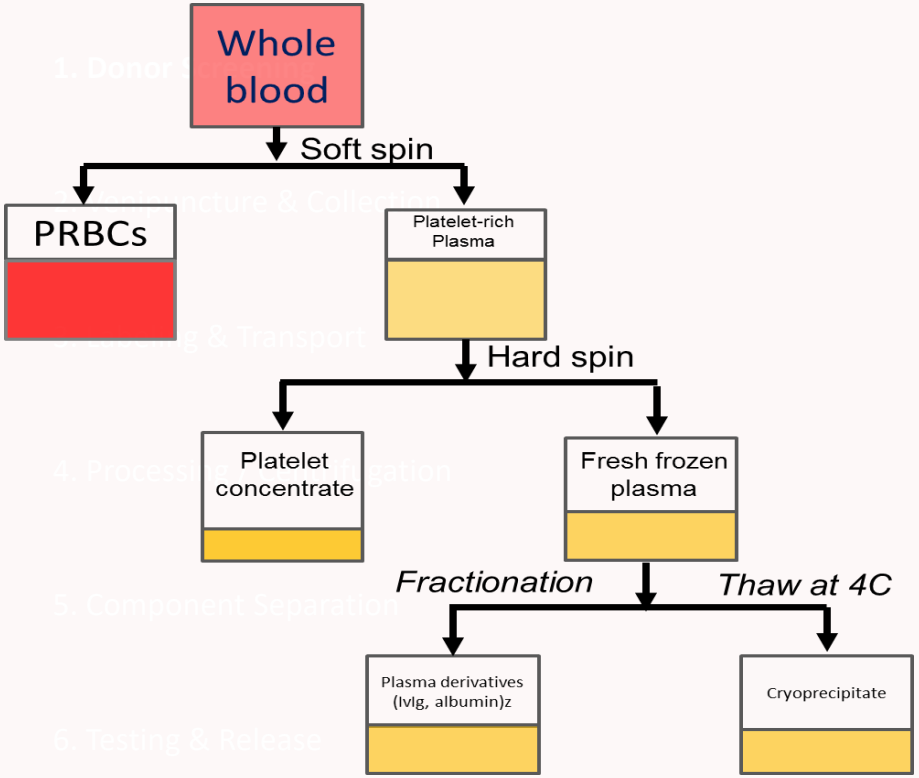
A single venipuncture collects ~450–500 mL of whole blood into a multi-component collection bag containing an anticoagulant.

1. **Donor Screening**
2. Venipuncture & Collection
3. Labeling & Transport
4. Processing / Centrifugation
5. Component Separation
6. Testing & Release

Whole Blood fractionation

The traditional model — one donation, multiple components





Whole Blood Collection

The traditional model — one donation, multiple components

Volume:	450–500 mL per donation
Anticoagulant:	CPD, CPDA-1, or AS additive
Processing:	Must be processed within defined time windows
Components:	Yields: 1 RBC unit + 1 FFP/PF24 unit + 1 buffy coat/PLT
Pathogen Testing:	Full serological & NAT testing required before release

1. **Donor Screening**
2. Venipuncture & Collection
3. Labeling & Transport
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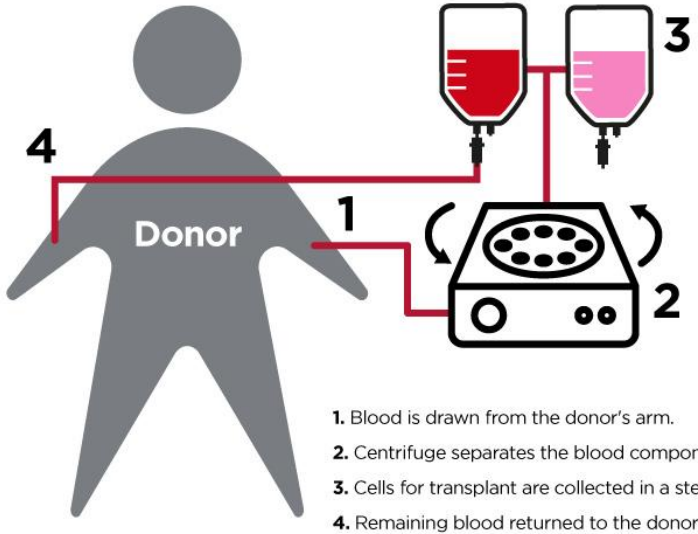
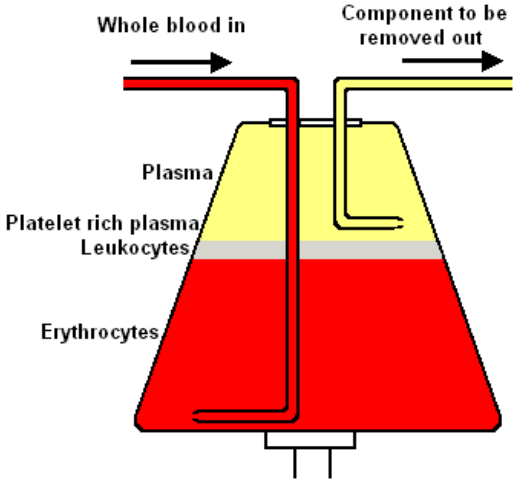
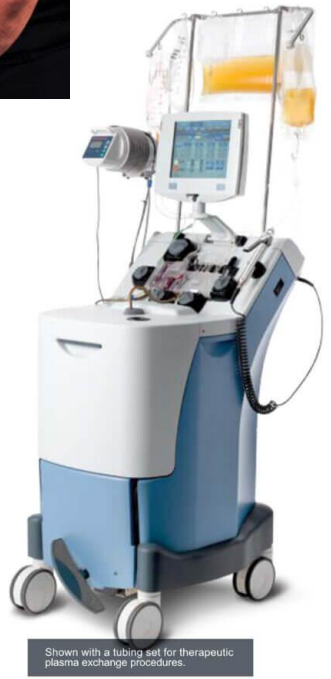
Apheresis Collection

Technology-driven selective component donation



1. Blood is drawn from the donor's arm.
2. Centrifuge separates the blood components.
3. Cells for transplant are collected in a sterile bag.
4. Remaining blood returned to the donor's other arm.





Definitions

Apheresis means “to separate and remove”

We can separate blood into its components:

Component	Donor	Therapeutic
Plasma	Plasmapheresis	Plasma exchange
Red blood cells	Erythrocytapheresis	Red cell exchange
Platelets	Plateletpheresis	Thrombocytapheresis
Granulocytes	Granulocyte collection	Leukocytapheresis
Stem cells	Stem cell collection	

Apheresis Collection

Technology-driven selective component donation

Apheresis uses automated cell separators to collect a specific blood component while returning the remainder to the donor in a continuous extracorporeal circuit.

Plateletpheresis

Yields 1 apheresis platelet unit ≡ 4–6 whole blood PLTs
~200–400 mL collected
Single donor — reduced alloimmunization risk

Plasmapheresis

Up to 800 mL per session
Source plasma (fractionation) or therapeutic
Frequent donations possible (every 4 weeks)

Leukapheresis

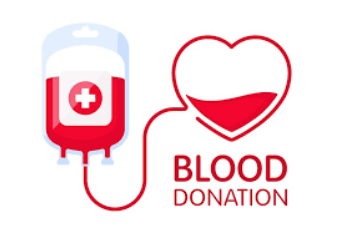
Granulocyte or MNC collection

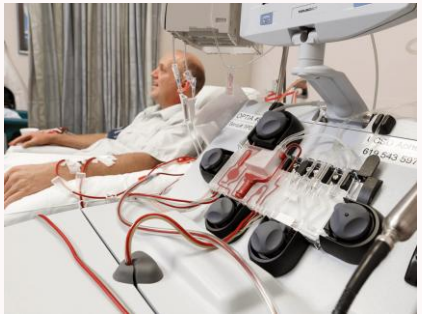
Double RBC

2 RBC units from one donor session
An extended deferral period after donation

Apheresis vs. Whole Blood: Side-by-Side

Feature	Whole Blood Donation	Apheresis Donation
Collection Volume	450–500 mL	Variable (200–800 mL)
Time Required	~10–15 min	45–120 min
Components Obtained	Multiple (after processing)	Targeted single component
Donor Exposures per Unit	1 donor per component	1 donor for full dose (PLTs)
Donation Frequency	Every 56 days (8 weeks)	Platelets every 7 days (×24/yr)



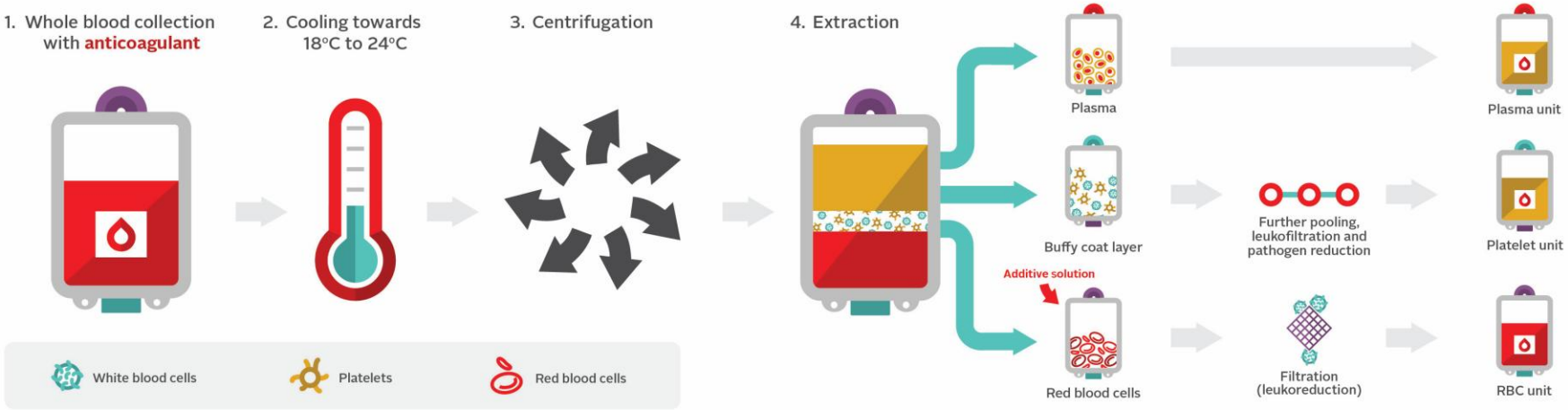


Advantages of apheresis donation

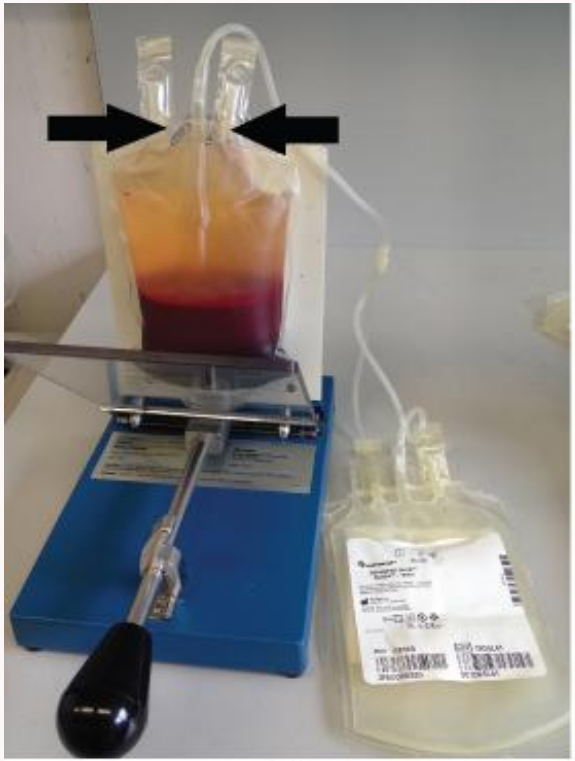
- Reduced donor exposure: full transfusion dose collected from one donor
- Frequent repeat donors: “pedigreed” donors with repeated screening and testing
- Higher quality products: more quality control per component collected
- Consistent and standardized product volumes and yields
- Ability to match donors to patients: HLA matching for platelet transfusions
- Double, triple, or multiple full-dose blood component collections
- Safety enhancement for the patient

Section 2: Component Manufacturing

The Reveos Automated Processing Platform


1. Whole blood collection with anticoagulant
2. Cooling towards 18°C to 24°C
3. Centrifugation
4. Extraction
White blood cells
Platelets
Red blood cells
Plasma
Buffy coat layer
Additive solution
Red blood cells
Plasma unit
Further pooling, leukofiltration and pathogen reduction
Platelet unit
Filtration (leukoreduction)
RBC unit

Whole Blood Processing



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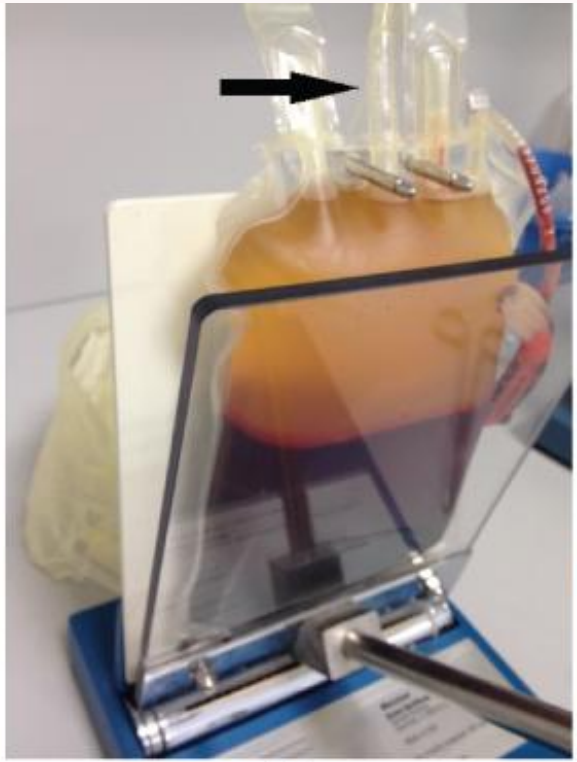

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Reveos™ Automated Whole Blood Processing

Terumo BCT — closed-system robotic component separation

The Reveos Automated Processing Platform by Terumo Blood and Cell Technologies is an FDA-cleared system (since Aug 2023) that automates the processing of whole blood into components—plasma, red blood cells, and platelets. It streamlines labor, reducing manual steps by up to 65%, and enhances platelet yield and consistency.

Reveos™ Automated Whole Blood Processing

Terumo BCT — closed-system robotic component separation

The Reveos system automates the separation of whole blood into RBCs, platelets, plasma, and buffy coat using a programmed centrifugation and extraction protocol within a closed sterile environment.

1 Load

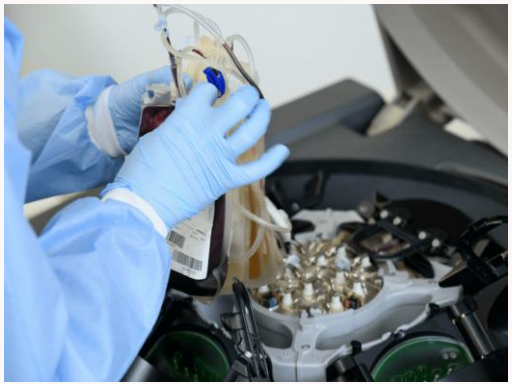
Up to 4 units loaded simultaneously into centrifuge cups

2 Spin

Controlled centrifugation separates layers by density

3 Extract

Optical sensors detect component boundaries



4 Transfer

Automated extraction into satellite bags

5 Release

Labeled & sent to storage / further processing

Reveos™ Automated Whole Blood Processing

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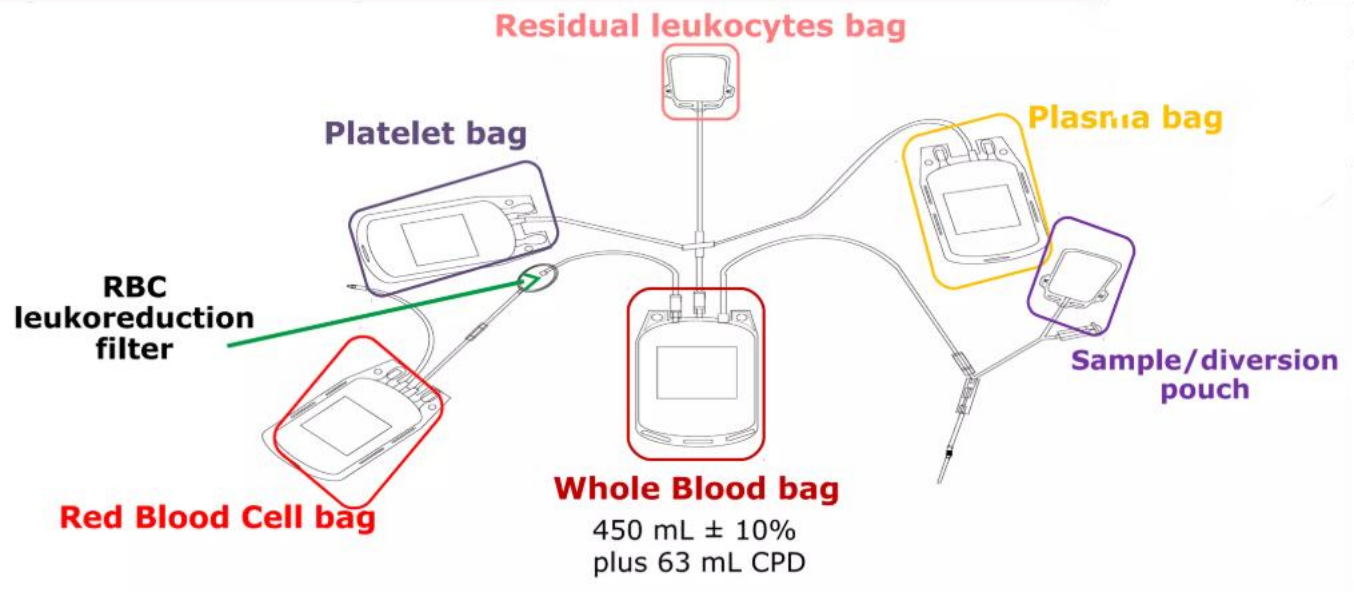


Reveos™ Automated Whole Blood Processing

Terumo BCT — closed-system robotic component separation

The Reveos system automates the separation of whole blood into RBCs, platelets, plasma, and buffy coat using a programmed centrifugation and extraction protocol within a closed sterile environment.

1	2	3	4	5
Load	Spin	Extract	Transfer	Release

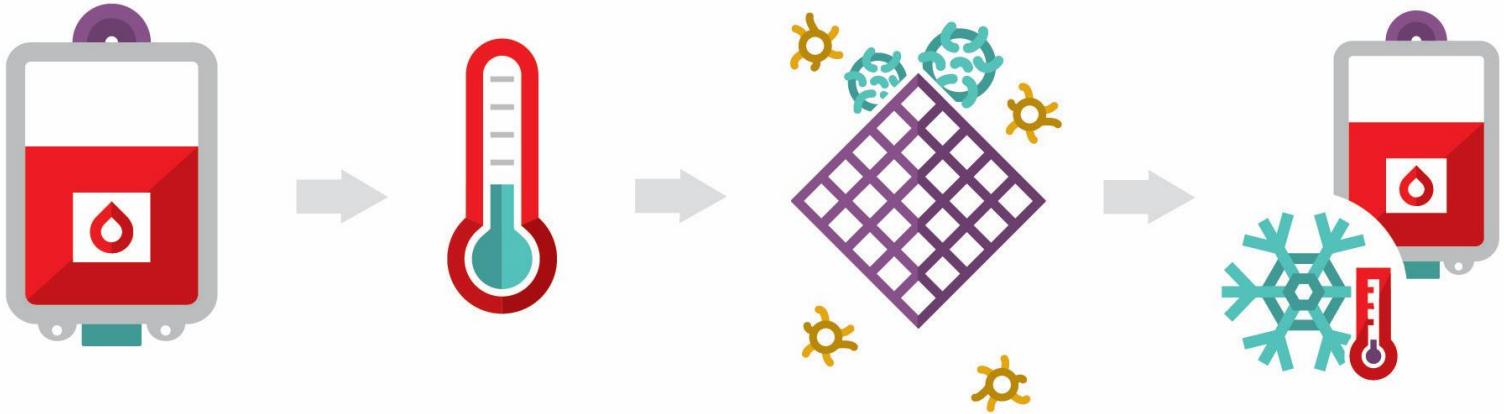
Key Advantages of Reveos

Closed System:	Eliminates open processing — reduces contamination risk
Standardized Yields:	Optical sensors + software ensure consistent extraction
High Throughput:	Processes multiple units simultaneously (up to 4 at once)
Buffy Coat Platelets:	Buffy coats pooled to make PC-WB platelets
Traceability:	Full electronic audit trail per unit

Section 3: Low Titer Group O Whole Blood

LTOWB in Trauma — ABO Titers & Hemolysis Risk

1. Whole blood collection with **anticoagulent**
2. Kept at room temperature
3. Filtration using a **platelet-sparing filter** to reduce leukocytes but maintain the platelet content of the unit.
4. The **leukocytes reduced** unit is stored at **1 – 6°C**



White blood cells Plaquettes

Low Titer Group O Whole Blood (LTOWB)

Whole blood from Group O donors, pre-screened for low anti-A and anti-B isohemagglutinin titers, enabling safe transfusion to non–group O recipients without requiring ABO typing in trauma and emergency situations.

Why Use LTOWB in Trauma?

- Contains all clotting factors, RBCs, and platelets in a near-physiologic ratio
- Avoids the '1:1:1' logistics complexity in damage control resuscitation
- Reduces total donor exposures for the trauma patient
- Can be available without time delay for ABO typing in pre-hospital and trauma settings

LTOWB Specifications

ABO Group:	Group O donors only
RhD:	Mostly available is D-positive
Anti-A Titer:	institution-defined_ ≤1:256 acceptable
Anti-B Titer:	Institution-defined_ ≤1:256 acceptable
Volume:	~450–500 mL with additive
Shelf Life:	21–35 days (4°C) depending on anticoagulant
Modifications:	Leukoreduced (platelet-sparing filters)

ABO Isohemagglutinin Titers & Hemolysis Risk

Group O blood contains naturally occurring anti-A and anti-B antibodies. When transfused to non–group O recipients, these antibodies can cause hemolysis of recipient RBCs.

Threshold: Most US programs: anti-A/anti-B ≤ 1:256 — though no universal consensus; some use ≤ 1:100

Hemolysis Risk Mitigation Strategies

- Screen all O donors with anti-A/anti-B titers — only include low-titer units in LTOWB inventory
- Volume considerations: hemolysis risk correlates with absolute volume of incompatible plasma transfused
- Switch to group-specific blood as soon as the type & screen result is available

Section 4: Blood Components

RBCs · Plasma · Platelets — Storage & Shelf Life

Red Blood Cells (RBCs)

Characteristics

Volume:	250–350 mL (with AS)
Hematocrit:	~55–65%
Additive Solution:	AS-1 (Adsol), AS-3, AS-5 — extends shelf life
Storage Temp:	1–6°C (refrigerated)
Shelf Life:	42 days with AS-1/AS-3/AS-5; 35 days CPDA-1
Expected Hgb rise:	~1 g/dL per unit in 70 kg adult
Irradiation effect:	Reduces shelf life to 28 days or original expiry, whichever is sooner

Clinical Indications

- Symptomatic anemia — fatigue, dyspnea, angina (typically Hgb < 7–8 g/dL)
- Acute hemorrhage with hemodynamic instability
- Perioperative anemia when Hgb < 8 in cardiac surgery/hip fracture
- Increase O2 carrying capacity to tissues

Plasma Components

FFP (Fresh Frozen Plasma)

Frozen ≤8h of collection
Full coagulation factor activity
1 year shelf life (frozen)
24h post-thaw at 1–6°C

PF24 (Plasma Frozen 24h)

Frozen ≤24h of collection
Slightly ↓ Factor V & VIII vs FFP
Adequate for most indications
24h post-thaw at 1–6°C

Thawed Plasma (5-Day)

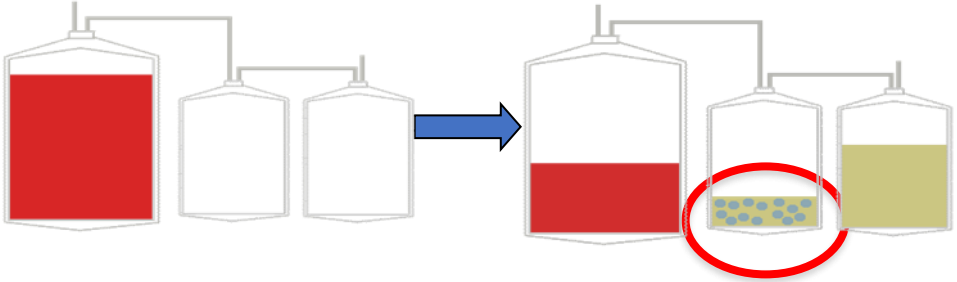
Thawed FFP/PF24 extended to 5 days
Factor levels acceptable for trauma
Immediate availability — no thaw delay
Preferred in trauma/massive transfusion

Liquid Plasma

Never frozen — stored at 1–6°C
Up to 26 days from collection
Used in pre-hospital / military settings
Factor levels lower than frozen plasma

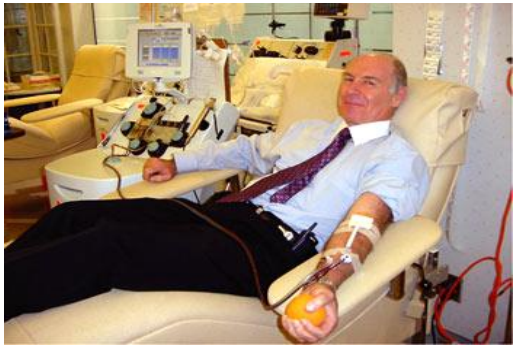
Platelets

- Whole blood derived platelets



  - 4 – 6 donors combined together to make 1 adult dose

- Apheresis Platelets



  - Single donor
  - Equivalent to 4-6 pooled units

Platelets — Types, Storage & Variations

Whole-blood–derived, Apheresis, PAS, and Pathogen-Reduced

Type	Source	Volume	Content	Shelf Life
Apheresis (single donor)	1 apheresis donor	150–300 mL	≥3×10^{11} PLT	5 days
WBD Pooled (buffy coat)	4–6 whole blood donations	~250–300 mL	≥2.4×10^{11} PLT	5 days
WBD Pooled (PRP method)	4–6 whole blood donations	~200–250 mL	≥2.4×10^{11} PLT	5 days
PAS Platelets (PAS-C/E)	Either source	~250–350 mL	Same count	5–7 days*
Pathogen-Reduced (Intercept)	Either source	~250–300 mL	Same count	5 days

**The extended 7-day shelf life requires enhanced bacterial detection testing (like LVDS) because the extended time increases the risk of bacterial growth.*

- *Any platelet unit — apheresis or WBD, PAS or plasma-based — can qualify for 7-day shelf life in the US provided it undergoes FDA-cleared secondary bacterial detection testing. PAS just makes that pathway work better in practice.*

Platelets — Types, Storage & Variations

Whole-blood–derived, Apheresis, PAS, and Pathogen-Reduced

PAS (Platelet Additive Solution)

- Replaces 60–65% of plasma with electrolyte/acetate solution
- Benefits: ↓ plasma volume → ↓ allergic reactions

Storage Requirements

- Temperature: 20–24°C (room temperature)
- Continuous gentle agitation required (rotator/flatbed)
- Must be in gas-permeable bags
- Risk: Bacterial contamination —requires BacTx testing or PRT

Clinical Indications

- Thrombocytopenia
- Prophylactic: plt < 10K (stable) or < 20K (with fever/infection)
- Pre-procedure: < 50K for minor; < 100K for CNS/ophthalmology
- Bleeding patient (dynamic state; goal 50-100K)
- Refractory: consider HLA-matched or crossmatched units

Cryoprecipitate

- Prepared by slowing thawing FFP in the cold
  - Insoluable precipitate
    - Factors VIII, XIII, vWF, **fibrinogen**
  - One ”pool” = 6-10 donor units = one adult patient dose

- Indicated:
  - Hypofibrinogenemia (< 100 - 150 mg)
  - Disseminated Intravascular Coagulation (DIC)
  - Obstetrical bleeding
  - Massive transfusion

Section 5: Component Modifications

Leukoreduction · Irradiation

Leukoreduction

Removing white blood cells to prevent transfusion complications

Leukoreduction removes ≥99.9% of leukocytes (residual WBC < 5×10^6 per unit) via filtration, reducing a spectrum of adverse transfusion reactions and immunomodulatory effects.

Benefits of Leukoreduction

- ↓ Febrile non-hemolytic transfusion reactions (FNHTRs)
- ↓ HLA alloimmunization
- ↓ CMV transmission
- ↓ TA-GvHD risk (partial, not complete — irradiation still required for at-risk patients)

When & How

Pre-storage LR:
Filtered at blood center within 8h — gold standard; also reduces platelet storage lesion

Post-storage / Bedside LR:

Less effective; acceptable if pre-storage unavailable

Universal Leukoreduction:
Policy adopted by UK, Canada, and many US centers — applies to all RBCs/PLTs regardless of indication

CMV-Safe Status:

Pre-storage LR is considered CMV-safe by FDA/AABB

Irradiation

Preventing transfusion-associated graft-versus-host disease (TA-GvHD)

Gamma or X-ray irradiation (25 Gy to the center of the unit, minimum 15 Gy to any point) inactivates donor T-lymphocytes, preventing engraftment and subsequent graft-versus-host attack on the immunocompromised recipient.

Indications for Irradiated Blood

- Hematopoietic stem cell transplant (HSCT)
- Lymphoproliferative malignancy
- Acute leukemia
- Chemotherapy – fludarabine, others
- Neuroblastoma
- Severe combined immunodeficiency (DiGeorge, SCID)
- Premature infants, intrauterine transfusions
- Patients and donors with shared HLA antigens (HLA-matched or crossmatch-compatible blood, directed donations from blood relatives)

Impact on Product

RBC Shelf Life:
Reduced to 28 days from irradiation or original expiry (whichever sooner)

Platelet Shelf Life:

Unchanged — irradiate within 5-day window

Hyperkalemia Risk:

Irradiation ↑ extracellular K^+ leakage from RBCs

Key Take-Aways

- Collection method (apheresis vs. whole blood) determines unit type, donor exposure, and workflow
- Reveos automates whole blood processing — improving standardization and throughput
- LTOWB is safe for non-O recipients when titers are screened (≤1:256 AHG) — switch to group-specific ASAP
- ABO isohemagglutinin titers are the critical safety parameter for LTOWB programs
- Platelets are the shortest-lived component (5 days) and require continuous agitation at 20–24°C

Canadian Circular of Information
https://www.blood.ca/en/hospital-services/products/component-types/circular-information

CIRCULAR OF INFORMATION

FOR THE USE OF HUMAN BLOOD AND BLOOD COMPONENTS

This *Circular* was prepared jointly by AABB, the American Red Cross, America's Blood Centers, and the Armed Services Blood Program. The Food and Drug Administration recognizes this *Circular of Information* as an acceptable extension of container labels. *Federal Law prohibits dispensing the blood and blood components described in this circular without a prescription.*

Association for the Advancement of Blood & Biotherapies

America's Blood Centers® It's About *Life.*

American Red Cross

ASBP Armed Services Blood Program

Post-presentation answers — did your thinking evolve?

Q 1 What is the primary advantage of component therapy over whole blood transfusion?

Component therapy allows **targeted treatment** —giving the patient only what they need, at the right dose, while conserving resources for other patients.

Specific advantages traditionally cited include:

- **Precision:** a thrombocytopenic patient gets platelets, not unnecessary RBCs or plasma
- **Reduced volume:** patient receives only the component needed, reducing circulatory overload risk
- **Optimized storage:** each component is stored under ideal conditions (RBCs at 1-6°C, platelets at 20-24°C, plasma frozen), maximizing shelf life and function
- **Inventory efficiency:** one whole blood donation yields multiple components benefiting multiple patients
- **Reduced donor exposure:** patients with chronic needs (e.g., thalassemia) receive only RBCs, not unnecessary plasma or platelets

Post-presentation answers — did your thinking evolve?

Q 1 What is the primary advantage of component therapy over whole blood transfusion?

Q 2 What laboratory value is used to define 'Low Titer' in Low Titer Group O Whole Blood (LTOWB)?

- Naturally occurring ABO antibodies in Group O donor plasma —specifically **anti-A** and **anti-B**, measured by serial 2-fold dilutions. The titer is reported as the reciprocal of the highest dilution still showing agglutination (e.g., a reaction at 1:256 = titer of 256).
- These titers assess the strength of antibodies against A and B antigens
- There is no universal cutoff; thresholds vary by institution

  Common definitions:
  ≤1:256 (frequently used)
  ≤1:100 (more conservative)
- Lower anti-A/B titers correlate with a reduced risk of hemolysis when transfusing group O whole blood to non–group O recipients.

Anti-A isohemagglutinin titer — serial dilution

Titer = reciprocal of highest dilution still showing agglutination → titer 128 qualifies as low titer (threshold ≤ 256)

Post-presentation answers — did your thinking evolve?

Q 1 What is the primary advantage of component therapy over whole blood transfusion?

Q 2 What laboratory value is used to define 'Low Titer' in Low Titer Group O Whole Blood (LTOWB)?

Q 3 Which blood component has the shortest standard shelf life under current storage guidelines?

Platelets
Shelf life: **5–7 days**
Stored at **20–24°C with agitation**
Short shelf life due to a higher risk of bacterial growth

Standard components ranked by shelf life (shortest to longest)

Component	Shelf Life	Storage
Platelets	5 days	20–24°C, continuous agitation
Thawed plasma (FFP/PF24)	5 days	1–6°C after thawing
RBC (CPDA-1)	35 days	1–6°C
RBC (AS-1/AS-3/AS-5)	42 days	1–6°C
FFP / PF24 (frozen)	12 months	≤ −18°C
Cryoprecipitate (frozen)	12 months	≤ −18°C

Questions?
Thank you for attending.